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ABSTRACT

The SAGRES system is an educational environment built on the World Wide Web that facilitates the presentation of the information bases of a museum in a way that is adapted to the individual characteristics of each visitor. The interaction with the system may occur individually or in groups of students. The system also offers resources to support some forms of cooperative learning, allowing visitors to interact both synchronously and asynchronously, as well as locally (inside the museum) and non-locally (in places geographically distant from the museum). This cooperative learning is stimulated and monitored by software agents that use the human-computer interaction paradigm called directed improvisation to interact with the user. While helping the user, the agents improvise behaviors similar to human behaviors (e.g., happiness, satisfaction, and vibration), making the interaction friendlier. (Contains 10 references.) (Author/MES)

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The SAGRES Virtual Museum with Software Agents to Stimulate the Visiting of Museums

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Abstract: The SAGRES system is an environment built on the Web, that facilitates the presentation of information bases of the museum, in a way which is adapted to the individual characteristics of each visitor. The interaction with the system may occur individually or in groups of students. The system offers also resources to support some forms of cooperative learning, allowing visitors to interact both synchronously and asynchronously, and both, locally, inside the museum, and non-locally, in places geographically distant from the museum. This cooperative learning is stimulated and monitorated by software agents that use the human-computer interaction paradigm called directed improvisation to interact with the user. The agents improvise, while helping the user, a group of behaviors similar to human behaviors (happyness, satisfaction and vibration), making the interaction more friendly.

1 Introduction

Most of the virtual museums on the Web are sites that offer on-line learning resources, inviting the visitor to investigate and to explore the information available. The SAGRES system is a virtual museum that seeks a cooperation between museum and schools, in order to create a new educational environment that provides continuous education, allowing access to information of the museum to the community in general. It aims to help cooperative learning processes of visitors, both local and remote. Due to the possibility of using the system as a distance teaching tool, and to the diversity of the school population to be reached, SAGRES was conceived as a flexible and adaptive system, able to pay attention to the different needs and situations of its various visitors.

The hypermedia systems on the Web are among the many systems that facilitate the adaptation of information. These systems are an efficient form to manage data collections too, as well as to bring into effect education and learning in museums. However, Yamada et al. [1995] state that hypermedia systems for education in museums present some limitations, such as: the lack of initial training from the part of the user; the time of limited use of the system (just during the visits); the different ages and the different levels of the users' background. To overcome these limitations, Nielsen [1990] emphasized the need to facilitate the use of such systems. They should be simple, so that the visitors can navigate without needing a training period, their simplicity, being related to the reduction of the navigation options in the interfaces.

Complementing Nielsen's proposal, we are using software agents to assist users in SAGRES. According to Genesereth [1994] software agents are very useful to analyze informantion and to monitorate the user's actions, helping them in the performance of tasks. In this way, the agents are able to facilitate the system's operation, to

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construct a user's history, with topics visited and activities performed, and to generate reports based on the user's history.

People are social beings and need to interact with each others. In fact, we enjoy and thrive on affective relationships with other social beings at home, at work and at play [Hayes-Roth 1998]. In this way, our agents are animated characters that resemble real and fictional characters. They do this, improvising a set of behaviors while executing the user's request.

We can visualize the organization of the whole system through figure 1. It shows that the SAGRES is built on the Web and the agents are running on SAGRES. The integration of the agents into the SAGRES was made through agents procedures calls inside SAGRES. At present, SAGRES can be reached at the URL http://sagres.mct.pucrs.br/.

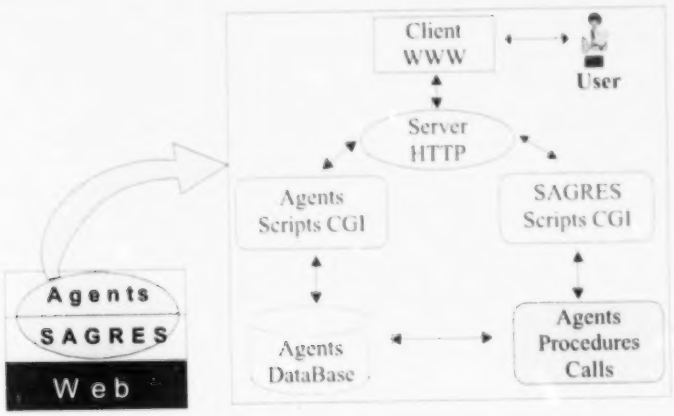

Figure 1: System Organization

2 SAGRES

The SAGRES system [Bertoletti 1999] is an educational environment, that facilitates the organization of visits to museums, presenting museums information bases in a way adapted to the user's characteristics (capacities and preferences). The system determines the group of links appropriate to the user(s) and showing them in a resultant HTML page. In addition, SAGRES carriers cooperative learning by supporting the interaction among visitors and also among members of groups of visitors.

SAGRES allows visitors to plan visits to the museum in advance. Thus, when arriving at the museum the visitor already knows from where to find the specific experiments. Later on, already at home, the visitors can read other information related to the visited experiments, as support material available in the system.

For teachers SAGRES is a powerful tool to support education, because it works as a repository of information from which the teacher can elaborate a library of activities (for example: questionnaires for tests) and share them with other teachers.

Basically, the system is handled by different groups of users:

- *System Administrator*: responsible for the maintenance of the system, having a deep knowledge about its
- *Information Manager*: responsible for the information bases of the museum, generating them and establishing the degree of difficulty of each piece of information.
- *Teacher*: is generally identified as a school teacher whose student groups visit the museum, being responsible for the definition of the profile of the group. By a profile we understand the set of characteristics of the

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group, that is, the students' background and preferences, any particular subject being focused in the visit, and the activities. The techer is also responsibility to register the students, as well as to accompany and evaluate their performance during the visit, through reports delivered by the system.

- *Visitor*: any individual visitor of the museum. A visitor can interact with the system as both is:
    - An Individual Visitor: he accomplishes the interaction with the system individually. He is included in the system by a process of self-registering, in which he is responsible for defining his profile, informing his characteristics, capacities and preferences, in order to facilitate the construction of his model.
    - A Student: he is allowed to change ideas with his group colleagues and to work in the activities and subjects determined by the teacher.

2.2 Adaptation of Information

In the adaptation process of SAGRES two main factors are considered: its use in the educational atmosphere (museum and school) and the different types of visitors that use the system. In this sense, the system uses an *adaptive presentation of information*, so that the user just receives, as a result of his consultation, the information that is in agreement with his level of understanding, stored in his visitor model.

The modeling module receives the information about the visitor, processes it and generates the visitor model, storing it in the database of models. The acquisition of knowledge about the visitor is done in an explicit way: information is directly extracted, through the filling of forms, with direct answers to questionnaires. SAGRES works with two kinds of models: individual model and group model. The individual model stores all the characteristics of the individual visitors. The group model is built by the teacher and used by students. The teacher is responsible for the definition of the students characteristics, by the definition of the group stereotype (subject, knowledge level and language of the consultation), the activities stereotypes and the classes (name of the students presented in the group). The activities stereotypes can contain: "n" questions (true or false; multiple choice; to relate columns and dissertation); "n" orders (that specify the teacher's desire before the students' course in the system); " n " editions of documents (where the teacher requests the students the report writing, for example) and " n " discussions (where the students change messages in order to discuss certain themes established by the teacher).

Once defined, the group and activities stereotypes can be used for the construction of several models, which store codes for the identification of them. The control of the use of the stereotypes fits to the teacher, that can also share them with other teachers.

The adaptation process accomplishes the mapping of the information (documents about the experiments in exhibition and works published by the staff of the museum) contained in the information bases for a presentation page, in accordance to the visitor's model. Such mapping results in a dynamically created HTML page, with links pointing to information selected. This page is created dynamically in each interaction and presents links to the documents, besides presenting connections to the communication mural (where visitors can interact with each other), to the document edition, and to the activities the visitor should perform (in case of a group visit). The visitor can use this page as a visitation guide to the museum.

2

The cooperation process in the SAGRES happens in two ways:

- Communication Mural: allows the students of a group to send messages to each other, facilitating local and remote communication among them, very important to the learning process. In this mural the students place their ideas, questions, comments and help messages. When the group model is created, the system automatically generates an HTML page, which works as a communication mural. The mural can only be used by the students of the group. The teacher also has access to this mural, facilitating the coordination of the cooperative process.
- Document Edition: The cooperation process in the SAGRES system also facilitates the edition of HTML documents on the part of the students. These documents, unlike the communication mural, are available to all users of the system. In such documents the students state their ideas on the consulted subjects, they add new information associated to that already presented and, also, arrange the related works.

3 Agents

In order to develop a system that can be more friendly, assisting the users in SAGRES, through the communication between the users and animated characters, our agents use the human-computer interaction paradigm called directed improvisation [Hayes-Roth 1997] . Based on the metaphor of the virtual theater, it was developed a muti-agent architecture formed by four kinds of agents: director, guide, presentation and assistant. Figure 2 shows the way these agents are organized. The innovative and peculiar feature of this architecture is the existence of the director agent, responsible to connect the behavior to the actors, in an improvised way. Therefore, the actors have different personalities and different ways to interact with users. We call this director's behavior "improvised direction", in order to distinguish it from directed improvisation.

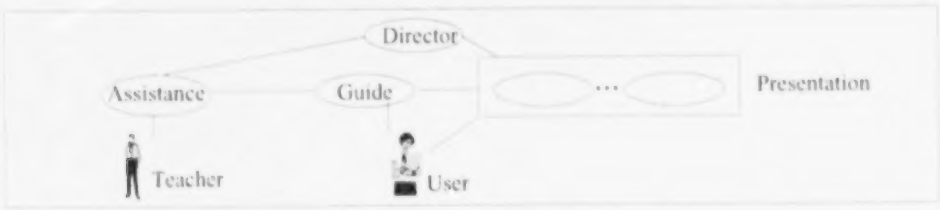

Figure 2: Global arquitecture of the agents

Hayes-Roth [1994] defined directed improvisation as a paradigm for human-computer interaction, where users give character abstract directions either interactively or in preconceived scripts. The characters improvise a course of behavior that follows the directions, expresses their individual styles and reflets social principles. The directed improvisation is incorporated in the architecture in the following way: each one of the agents has a script that contains the actions to be executed by the agent and a behavior related to these actions. Two kinds of behaviors have been defined: interaction, which occurs when the agent interacts with the user, and processing, which occurs when the agent processes a request from the user. The interaction behaviors incorporate the verbal behaviors (word choices) and physical (movement behaviors) of the agents. It has associated instances for each of the interaction behaviors of the agents. As the verbal behaviors define the personality of the agent, we defined different "personality instances" for the guide agents, presentation and assistant, provinding varied personalities to them. The director agent is responsible to choose, in an improvised way, which behaviors will be related to the agents actions. Figure 3 shows the director's script, with some of its funcionalities. The guide agent is responsable to assist users and built their history. A reduced format of the guide agent script is presented in the figure 4; the text in italic is representing the behavior that the agent can improvise at that moment.The assistant agent helps teachers to construct visits and to monitorate a students' group and the presentation agent presents the contents requested by the users.

We may notice in the figure 4 that an action can have more than one associated behavior. In this way, the agent has to choose which behavior will be improvised. Beyond these scripts each agent has a data structure, the same for all, that is: id_agent (contains the name of the agent), state_agent (contains the current internal state of the agent), list_neighbours (contains the name of the agents that it will be able to communicate to) and who_is_communicating (contains the name of the agent that is communicating at the moment). The agents have common knowledge about the world, which is implicitly incorporated in the program structure.

1. To construct the agents' scripts, connecting, in na improvised way, behaviors to the agents' actions.
2. To inform these scripts to the agents.
3. To manage the execution of the agents.
4. To create a solution when it doesn't exist a guide agent to guide a user or it doesn't exist a presentation agent to present some specific topic requested by the user.

Figure 3: Example of Director agent's script

1. To present to the visitor (*to greet, to wave)*
2. To invite the visitor to make a visit to the museum *(to invite, to dance)*
3. To wait reply of the visitor *(to wait)*
   - 3.1 If visitor selects a consultation
     Looks to presentation agent for content (*researcher)*
     Demonstrates satisfaction *(satisfaction, vibration)*
   - 3.2 Else demonstrates reprovation *(to refuse, to disapprove)*
     Stimulates visitor to make visit *(to stimulate, to move)*
   - 3.3 If visitor requests mural's monitoring
     Monitorate communication mural *(investigating, artist)*
   - 3.4 If visitor requests the monitoring of document edition
     Carries through edition of document *(researcher, artist)*

Figure 4: Sample of Guide agent's script

The communication between agents is carried out through sending and receiving messages. A set of messages was created to use in the interaction between agents; some of these messages can be seen in figure 5.

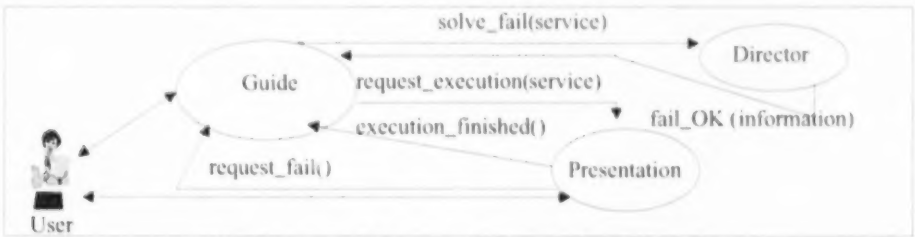

Figure 5: Sample of Communication in an individual visit

Running on SAGRES, the agent carries through the assistance of users, constructing the users' history, that is the topics visited and activities performed. The agents are constantly looking for new messages in the communication mural and informing the user who writes the message and what is its content. The agents execute also the procedure of looking for documents edited by other users, suppling access to these documents. The system also supports some facilities to the teacher, when a group visit is occuring. Based on the user's history, the agents generate reports to the teacher. There are three kinds of reports: group's report, that lists all activities made by the group, including communication mural and document edition, student's report (lists activities partialy or completly performed by the student, with his grade) and activities' report (lists percentage of activities finished by the group and degree of correct and incorrect answers).

4 Conclusion

A virtual museum, in the pattern proposed by SAGRES, is shown viable, performing among other functions, the support for cooperative learning. SAGRES is being developed to offer to the visitors of museums (local or remote visitors) the chance to learn cooperatively, exploring information adapted to their personal characteristics. The style of SAGRES system demands that the student takes part in the decisions concerning the activities he will perform, and not only to repeat preset routes mechanically.

This way, SAGRES will make remotely available to the public visitor the interactive museum of PUCRS, as well as it will contribute to the improvement of teaching, facilitating cooperative work among students, and promoting the exchange of information among schools geographically distant.

The agents in SAGRES are built in order to offer a friendly interface and to facilitate the management of groups' visits.They do this through the assistance of users, helping them during the exploration of information and system operation. Furthermore, they stimulte communication among students and among visitors, because they are constantly looking for new messages in the communication mural and informing the user the author and contents of the message. Besides, they provide facilities to monitorate group of students.

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